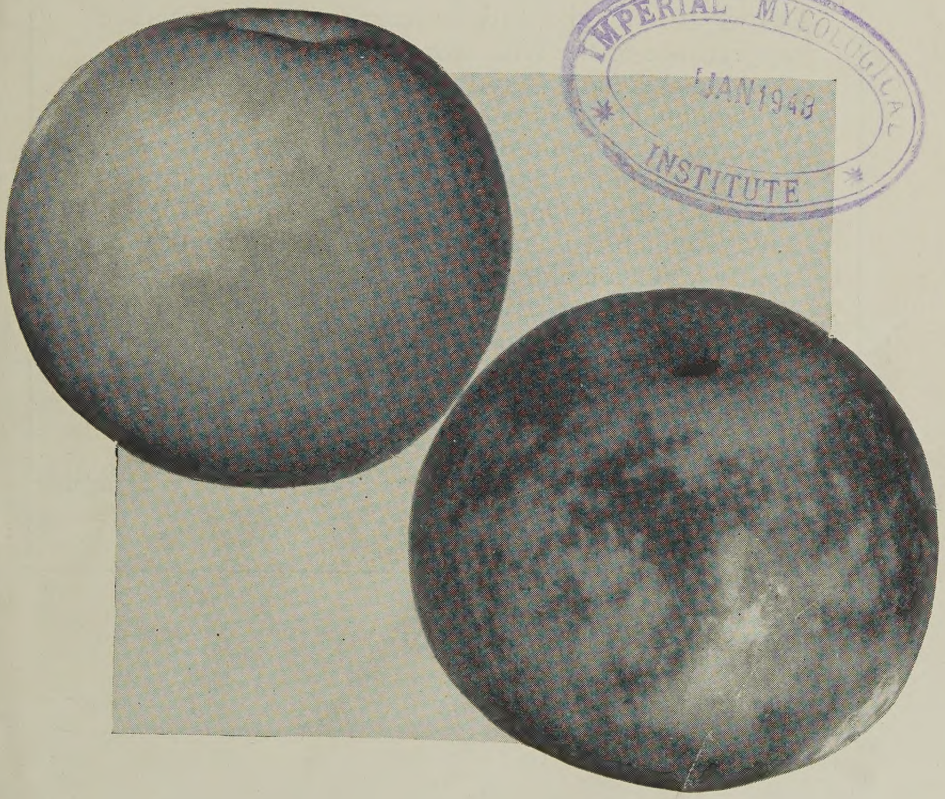
APPLE SCALD and its control



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SCALD is one of the most serious diseases that affect apples during storage and marketing. It affects the appearance of the fruit more than its eating quality. Scalded skin is dead and offers no further protection to the apple. Scald control, therefore, is essential if the crop is to be stored and marketed successfully.

Apple scald is influenced by the cultural conditions under which the fruit is grown, by the stage of maturity at which it is harvested, and by the conditions under which it is stored. This bulletin gives the essential known information about the disease and the methods of controlling it. The most practicable method of controlling scald is by the use of oiled paper, either as wrappers or in shredded form.

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APPLE SCALD AND ITS CONTROL[1]

By D. F. Fisher, *principal horticulturist*, and J. S. Cooley, *senior pathologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration*

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IMPORTANCE OF SCALD CONTROL

SCALD, one of the most serious storage and market diseases of all varieties of apples a quarter of a century ago, is now of much less commercial significance because of the rather general use of the oiled-paper method of control discovered and recommended by the United States Department of Agriculture. Many shippers, handlers, and consumers, therefore, do not appreciate how important it is to control scald in handling, storing, and marketing apples. Apple growers seldom see this storage and market disease and appreciate only its effect upon the returns from their crops.

Scald may appear on fruit from any apple-producing district. Although varieties differ widely in susceptibility to scald, none is immune. Among the most susceptible varieties are Grimes Golden, Stayman Winesap, Arkansas (Black Twig), Rome Beauty, Cortland, and York Imperial. Scald rarely develops to a significant degree on Jonathan, McIntosh, or Golden Delicious. Other varieties are intermediate in susceptibility to scald. Immature apples are more affected than those picked later; the unblushed side of the fruit is affected most. Unlike apple rots, scald is not caused by molds or bacteria. It is caused by certain unfavorable conditions to which the apples are sometimes subjected; seasonal and cultural conditions, as well as those encountered during the transportation, the storage, and the marketing of apples, are involved.

[1] Original bulletin written by Charles Brooks, formerly principal pathologist, Division of Fruit and Vegetable Crops and Diseases, and the present authors.

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Scald is sometimes confused with soft scald; the unfortunate similarity of the names commonly used for these two distinct storage disorders adds to the confusion. Soft scald is usually seen in well-marked patterns. Often it occurs in bands with sharp edges. Eventually it causes the skin to become depressed but tightly drawn over the affected areas. This disease makes the apples look as though they had been rolled over a hot stove. Soft scald appears on the apples while they are still in cold storage, but it is seldom seen before about the middle of December. The first symptoms are fading and diffusion of the red pigments in the skin; browning of the surface and underlying flesh tissue follows; and the browning becomes progressively worse as time goes on. Soft scald is most commonly found in Jonathan and Rome Beauty, but Winesap and Delicious are sometimes affected. Unlike scald, it cannot be controlled by use of oiled paper. The most practicable means of preventing loss from soft scald is to store the apples at a temperature of about 36° instead of 30° to 31° F.

Scald may show up on untreated apples still in commercial storage 60 to 150 days after harvest, but it develops most rapidly on fruit removed from storage to the warmer air of the market and the home. When removed from storage the apples may appear to be in perfect condition, but a few days later their market value may be reduced 15 to 30 percent or even more because of the development of scald. A disease that appears suddenly when the apples are ready for eating disturbs the market. Furthermore, it causes heavy losses, limits distribution, and decreases consumption.

APPEARANCE AND CHARACTERISTICS OF SCALD

In mild cases of scald the apple is merely tinted with brown and the skin remains firm; in more severe cases the skin tissue may be broken down so much that it sloughs off readily from the underlying flesh. In some instances the flesh becomes dead and brown to a depth of half an inch. Then, the disease takes on an appearance somewhat similar to that of an apple rot; but true rot usually spreads more or less conically into the flesh, whereas scald affects a considerable area of the apple to a rather uniform but shallow depth. However, apples with skin killed by scald are readily invaded by rot organisms which soon finish the work of destruction.

Scald differs from all other diseases in being more prevalent on the green, or unblushed, side of the apple. Bright-red areas on mature fruit are highly resistant to scald, and yellow areas are much more resistant than those that are green or that show the first stages of turning from green to yellow.

EFFECT OF ORCHARD CONDITIONS

MATURITY AND COLOR OF APPLES

The maturity and color of apples at picking time are very important factors in determining their susceptibility to scald; the more mature fruit scalds less than that which is greener. In general, fruit that is matured but not overripe develops less than half as much scald as that which is picked green.

Color and maturity are influenced by weather conditions, pruning, soil, fertilizer, and general orchard management, as well as by time of picking. Heavy applications of nitrogenous fertilizers make apples more susceptible to scald; good exposure to sunlight produces high color and makes apples more resistant. However, the red bud sports of Delicious, Stayman Winesap, and Rome Beauty become well colored before they are mature enough to develop resistance; consequently they may be affected by scald if harvested before they reach the proper stage of maturity. With red bud sports as with other kinds of apples it is best to time the harvest on the basis of the length of time from date of full bloom. For Delicious this is 145 days or more; for Stayman Winesap, 160 days or more; and for Rome Beauty, 155 days or more.[2]

SOIL MOISTURE

The effect of soil moisture on the susceptibility of the fruit to scald is most noticeable under irrigation conditions, but it is often seen also in fruit from nonirrigated trees. Apples from heavily irrigated trees or from trees that have received heavy late rainfall often develop three times as much scald after removal from storage as those from lightly irrigated trees or from trees that do not receive late rainfall.

SIZE OF APPLES

In general, large apples are more susceptible to scald than small ones, but this difference in susceptibility is apparently due not so much to size in itself as to the forcing that induces size and the poor color that usually accompanies it. Apples may develop good size without becoming unduly susceptible to scald if they are well colored and properly matured.

EFFECT OF PACKING-HOUSE, TRANSPORTATION, AND STORAGE CONDITIONS

Although orchard and seasonal conditions are important factors in determining the susceptibility of the fruit to scald, the conditions that prevail after apples are picked determine the extent to which scald will develop. When apples are removed from the tree, they are still alive and continue to carry on most of their life processes. However, since they have been cut off from their original source of food and water, they should be given conditions that will conserve their stored supplies and yet allow their life functions to proceed in a normal manner. In other words, they must be kept under proper conditions of temperature and humidity.

TEMPERATURE

Low temperature is the best means known of prolonging the life of apples; it is also important in delaying the development of scald. Apples should be cooled as quickly as possible after picking and should be delivered to the storage plant promptly. The storage con-

[2] For further information see Circular 711, PICKING MATURITY OF APPLES. May be consulted in libraries or purchased from the Government Printing Office, Washington 25, D. C., for 10 cents.

ditions should be such that there will be the least possible delay in bringing the fruit to the final storage temperature. Placing large quantities of warm fruit in a single room or pile results in delayed cooling and consequent increase in scald.

Many serious losses from scald are caused by delayed cold storage. Apples that are delayed in unrefrigerated cars, in closed packing sheds, or in large stacks under any condition are almost certain to show a greatly increased tendency to scald and to have their storage life decidedly shortened by the treatment.

AERATION AND VENTILATION

Free exposure to the air is often as important in scald control as is low temperature, because it actually decreases the tendency of the fruit to scald instead of merely delaying the development of the disease. It is important to keep the atmosphere of the storage room from becoming too dry; otherwise, the apples will wilt or shrivel. The greater the rate of air movement over the apples the higher the humidity should be. The relative humidity of the air should be kept above 85 percent at all times; a range of 85 to 90 percent is generally most satisfactory.

Aeration Before Storage

There is no other time when good air movement over apples is so important as when they are delayed in going into storage. When apples cannot be placed in cold storage immediately after harvest, a great deal can be accomplished in scald control by keeping them in the shade and giving them the freest possible exposure to the air; but it should be borne in mind that delay in cooling is also favorable to the development of rots and always shortens the life of the apples.

Aeration in Storage Room

Apples that are on the aisles or near the doors of cold-storage rooms scald less than those that are located in the middle of the stacks. Whatever contributes to the openness of the storage stacks and to the freedom of air movement through them is of value in scald control.

Apples often scald less in air-cooled storage than in commercial cold storage. Probably in such cases the benefits of the better air movement outweigh the harmful effects of the higher temperatures insofar as scald is concerned. When air-cooled plants are tightly packed with fruit and but little attention is paid to ventilation, scald is likely to be extremely bad.

The aeration and the ventilation given during the first 6 to 8 weeks of storage are of the greatest value in scald control. After that time the more susceptible varieties usually develop a tendency to scald that ventilation cannot correct.

Ventilation of Packages

The tightness of the package influences the development of scald. In general, less than half as much scald can be expected on apples in open packages as in those that are tightly closed.

Apples in well-ventilated packages cool more quickly in storage than those in tight ones; this in itself is of value in scald control as well as in the prevention of rots and the conservation of the life of the fruit. The greatest value of ventilated packages so far as scald is concerned lies, however, in the freer exposure of the apples to circulating air.

Effects of Free Air Circulation

The question naturally arises as to what the air brings to the apples or what it carries away that makes its free circulation of value in scald control. It has been proved that the scald control resulting from air movement is not due to the oxygen brought to the apple or to the carbon dioxide carried away. In fact, it has been found that subjecting the fruit to high percentages of carbon dioxide at the beginning of the storage season delays the ripening of the apples and greatly decreases the development of scald.

It is also known that the odorous substances emanating from apples may become definitely harmful and produce scald when present in sufficient concentration. Therefore, it seems probable that the value of aeration in scald control is that it removes these odorous products thrown off by apples.

SCALD CONTROL BY USE OF OILED PAPER

The most efficient and practicable method of controlling scald now known is the use of oiled paper. Oiled paper is almost universally used when apples are wrapped; when they are not wrapped shredded oiled paper is scattered through the package.

Oiled wrappers do not completely control scald in all cases, but they hold the disease in check to such an extent that the market value of the fruit is preserved. Under average market conditions 5 percent of scald in western boxed apples or 10 percent in eastern apples would mean a discount in price; 25 percent of scald in western boxed apples or 50 percent in eastern apples would be likely to result in a cut of 25 percent or more in the market price. That such losses can be avoided by use of oiled-paper wrappers is shown in figures 1 and 2.

Oiled paper not only delays the development of the disease, but removes the tendency of the fruit to scald. There is usually less scald on apples in oiled paper toward the end of the storage season than on unwrapped fruit 3 months earlier.

The oiled paper must carry at least 15 percent of its finished weight in odorless, tasteless mineral oil if it is to give satisfactory scald control; and 18 to 20 percent of oil is highly desirable.[3]

When shredded oiled paper is used, it should be cut so that it can be readily scattered in the package. The strips are usually about 5 inches long and three-eighths of an inch wide. For use in shredded form a paper that is somewhat resilient and springy is better than one that is soft and inclined to mat. Such paper is easier to shake apart after it has been baled, and when thrown into the package it

[3] For detailed specifications for apple wraps both dry and oiled see [U. S.] NATL. BUR. STANDARDS. APPLE WRAPS. Commercial Standard CS44–32, 12 pp. 1933.

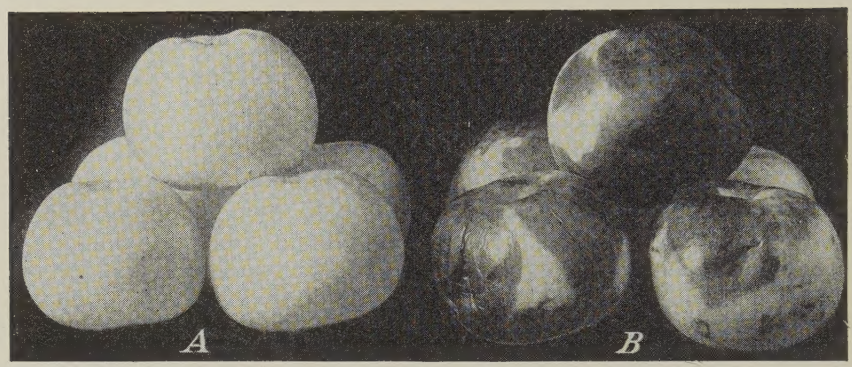

FIGURE 1.—Yellow Newtown apples from Winchester, Va., picked on September 30 and photographed the following July 1: *A*, Wrapped in oiled papers; *B*, unwrapped.

has a greater tendency to spread out between the apples and give the maximum contact with them.

If the paper is evenly distributed, half a pound to the bushel is usually sufficient to give satisfactory scald control; but three-quarters of a pound gives better results with susceptible varieties. In any event the shredded oiled paper should be well distributed among the apples in the package. The use of a handful only on top of the package for decorative purposes is of no value in scald control.

For oiled paper to be most effective the apples should be packed in it within a short time after harvest. No control can be expected if the packing in oiled paper is delayed 2 months or more.

FIGURE 2.—Grimes Golden apples in oiled and unoiled wrappers, removed from cold storage at Wenatchee, Wash., February 13 and photographed March 1.

EXPERIMENTALLY SUCCESSFUL METHODS OF SCALD CONTROL

For more than 25 years, since the oiled-paper method of scald control was discovered and introduced by the United States Department of Agriculture, oiled paper in wrapper or shredded form has continued to be the most practical means of scald control. Certain other methods, however, have been effective under experimental conditions and may ultimately prove to be commercially applicable, but as yet none of them is in extensive use. Included in the newer experimental methods are the following:

1. Circulating the storage air through activated charcoal or over it to remove the injurious substances given off by the apples.
2. Holding the apples in a high concentration of carbon dioxide for a few days before placing them in cold storage.
3. Application of certain chemicals which regulate physiological activities of plant tissue. One of these chemicals that offers considerable promise is α-naphthaleneacetic acid applied with emulsified lanolin.

All of these methods avoid the necessity of wrapping the apples or of packing them in shredded oiled paper. Doubtless they would be regarded with favor for that reason, particularly in retail markets where the fruit is placed on display and the labor of removing the paper is an item to be considered. No definite statement as to comparative costs involved in the different methods can be made, but regardless of the method used it is certain that the cost of scald control will be less than the loss that would otherwise be sustained.

CRITICAL PERIODS IN SCALD CONTROL

The life of the stored apple may be divided into four different periods, or stages, with reference to the development of scald.

The first period begins with the picking of the fruit. For the more susceptible varieties it ends after 6 to 8 weeks in cold storage. During this time the scald-producing factors are apparently most active; yet up to the end of the period it is possible largely to overcome the accumulated tendency to the disease by placing the apples in oiled paper or by giving them a very thorough airing.

The second period in the development of scald is the 5- to 8-week period after the first. Preventive measures then become of little or no avail. The apples may scald if given sufficient time; but if they are removed from storage and used before the end of this 5- to 8-week period the scald problem is avoided even when the apples become warm.

The third period covers the remainder of the time the fruit is in storage. By that time the apples are latently or potentially scalded, and certain skin cells are practically dead; yet they remain green and appear normal if not exposed to warm air.

The fourth period includes the life of the apple after its removal from cold storage and exposure to warmer air. The affected skin turns brown because it is dead. The apple being thus deprived of its protective skin soon becomes rotten.

AFTER-STORAGE BEHAVIOR OF APPLES

If the storage rooms are opened but little and the temperature is held constantly at 30° to 31° F., scald may not become evident until the apples are removed from storage. Such delays in the appearance of scald have often resulted in serious disputes over responsibility for its occurrence and accountability for the losses caused thereby. The rate of scald development after removal of the apples from storage will depend upon the temperature to which the fruit is exposed. During the winter months apples are often passed on to the consumer before scald becomes seriously evident, but during the late spring months the disease is likely to develop in transit or on the market.

LOSSES FROM SCALD

Before the use of oiled paper became general market-inspection reports showed that apple scald was a close second to blue mold in causing loss during storage. From the middle of December until the close of the apple season apples were often offered at a 10- to 40-percent discount because of scald. The lower price was due not entirely to the bad condition of the fruit at the time of sale, but often to fear that the disease would become rapidly worse. When scald began to appear in commercial storage lots, the dealer knew that the fruit could not safely be held for more favorable prices and usually he moved it to market and sold it for what it would bring. The losses and spoilage from scald varied with the season, the locality, and the size of the crop. More scald was evident in southern markets than in northern ones, more during warm periods than during cool ones, and more in a year when the fruit moved slowly than when there was a ready sale.

Besides the wastage of fruit and the lowered price resulting from scald, there were general effects upon distribution and consumption that were distinct handicaps to the apple industry. The disease became a limiting factor in distribution to smaller centers and in after-storage shipments in general. Apples that were rushed through the market as scald began to develop often became badly scalded in the hands of the consumer; this not only caused him a direct loss but also deterred him from continuing to buy apples freely.

It is not usually recognized that the general use of oiled paper during the past 25 years has removed scald as a major cause of market loss. Many present-day shippers and handlers, therefore, do not appreciate how important scald control really is in the successful handling, storage, and marketing of an apple crop.

PRACTICAL RECOMMENDATIONS

To prevent apple scald the following procedures are recommended:

1. Store only mature, well-colored fruit.
2. Store fruit at 30° to 31° F. as soon as possible after harvest.
3. When it is impossible to store fruit immediately after harvest, keep it in the shade and give it free exposure to the air.

4. Keep atmosphere in the storage room at 85 to 90 percent relative humidity.
5. Wrap fruit in oiled (not waxed) paper at harvest or within not more than 2 months after harvest. Or scatter shredded oiled (not waxed) paper throughout packages of non-wrapped fruit. (The oiled paper should carry at least 15 percent of its finished weight in odorless, tasteless mineral oil.)
6. Use well-ventilated packages and stack so that air can circulate freely.
7. Market apples not protected by oiled paper before scald develops (usually within 60 to 90 days after harvest).

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